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मानक

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Mazdoor Kisan Shakti Sangathan

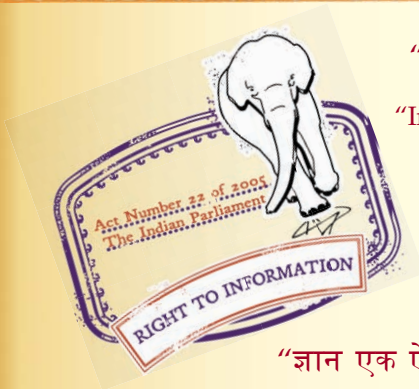
“The Right to Information, The Right to Live”

“पुराने को छोड़ नये के तरफ”

Jawaharlal Nehru

“Step Out From the Old to the New”

IS 13360-5-12 (1992): Plastics - Methods of Testing, Part 5: Mechanical Properties, Section 12: Determination of Ball Indentation Hardness [PCD 12: Plastics]



“ज्ञान से एक नये भारत का निर्माण”

Satyanarayan Gangaram Pitroda

“Invent a New India Using Knowledge”



“ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है”

Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”

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भारतीय मानक

प्लास्टिक – परीक्षण पद्धतियाँ

भाग 5 यांत्रिक गुणधर्म

अनुभाग 12 प्लास्टिक की बॉल-बुलरुण कठोरता ज्ञात करना

Indian Standard

PLASTICS — METHODS OF TESTING

PART 5 MECHANICAL PROPERTIES

Section 12 Determination of Ball Indentation Hardness

UDC 678.5/.8 : 620.178.152.2

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BUREAU OF INDIAN STANDARDS
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FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Methods of Test for Plastics Sectional Committee had been approved by the Petroleum, Coal and Related Products Division Council.

This method has been aligned with ISO 2039-1 : 1978 'Plastics — Determination of hardness — Part 1 : Ball indentation method' issued by the International Organization for Standardization (ISO).

In reporting the result of the test made in accordance with this standard, if the final value, observed or calculated, is to be rounded off it shall be done in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'.

**AMENDMENT NO. 1 JANUARY 1999
TO
IS 13360 (PART 5/SEC 12) : 1992 PLASTICS —
METHODS OF TESTING
PART 5 MECHANICAL PROPERTIES**

Section 12 Determination of Ball Indentation Hardness

(Page 2, clause 8.5) — Insert the following Note at the end:

“NOTE — In some cases, it is difficult to obtain test specimens that are exactly flat. If such slightly warped test specimens are used, part of the measured ‘depth of impression’ will in fact correspond to the distance travelled by the indenter in pressing the test specimen down on to the supporting plate. This difficulty can be overcome by using a supporting plate of diameter 10 ± 1 mm. This diameter is also sufficiently large for perfectly flat test specimens.”

(Page 3, Annex A) — Insert the following at the end of the table:

‘NOTE — When the ball indentation hardness of a test specimen is in the transition zone between one test load and the next, slight differences in the ball indentation hardness may result if the test is carried out either with the smaller test load at a low depth of impression or with the larger test load at a high depth of impression. In such cases, it is recommended that the test load to be used be agreed upon between the interested parties.’

(PCD 23)

*Indian Standard***PLASTICS — METHODS OF TESTING****PART 5 MECHANICAL PROPERTIES****Section 12 Determination of Ball Indentation Hardness****1 SCOPE**

This standard describes a method for determining the hardness of plastics and ebonite by means of a loaded ball indenter.

2 REFERENCES

The following Indian Standards are necessary adjuncts to this standard:

<i>IS No.</i>	<i>Title</i>
196 : 1966	Atmospheric condition for testing (<i>revised</i>)
2828 : 1964	Glossary of terms used in the plastics industry
13360 (Part 1) : 1992	Plastics — Methods of testing: Part 1 Introduction

3 TERMINOLOGY

3.1 For the purpose of this standard the definitions given in IS 2828 : 1964 and the following shall apply.

3.2 Ball Indentation Hardness—The quotient of the load on the ball indenter by the surface area of the impression caused by the ball indenter after a specified time of load application. It is expressed in newtons per mm².

4 PRINCIPLE

The method consists of forcing a ball under a specified load into the surface of the test specimen. The depth of impression is measured under load. The surface area of the impression is computed from its depth. The ball indentation hardness is then calculated from the following relationship:

$$\text{Ball indentation hardness} = \frac{\text{Applied load}}{\text{Surface area or impression}}$$

5 APPARATUS

5.1 The apparatus shall consist essentially of a frame with an adjustable platform fitted with a plate to support the test specimen, an indenter with its associated fitting and a device for applying the load without impact.

The apparatus shall be equipped with a device to measure the depth of penetration of the indenter with the accuracy indicated in 5.5.

The frame shall not be deformed under the maximum load by more than 0.05 mm, the deformation being measured along the main axis of the applied force.

5.2 The indenter shall be made from hardened steel and shall be polished. The ball shall not show any deformation or damage after the test.

The diameter of the ball shall be 5.0 ± 0.05 mm.

5.3 The initial load F_0 (tolerance ± 1 percent) shall be 9.8 N.

5.4 The test load F_m (tolerance ± 1 percent) shall have one of the following values:

49.0 N, 132 N, 358 N, or 961 N.

5.5 The depth measurement range of the apparatus shall be 0.400 mm, measurable to an accuracy of ± 0.005 mm.

5.6 A timing device, accurate to ± 0.1 second.

6 TEST SPECIMEN

The test specimen shall be a smooth flat sheet or block of sufficient size to minimize the edge effect on the test result; for example 50 mm $\times$ 50 mm. The surfaces of the test specimen shall be parallel. A thickness of 4 mm is recommended.

The supported surface of the test specimen shall not show any deformation after testing.

7 CONDITIONING

The test specimens shall be conditioned, prior to testing, in accordance with IS 196 : 1966 and IS 13360 (Part 1) : 1992.

8 PROCEDURE

8.1 Unless otherwise specified, carry out the tests in the standard atmospheric conditions specified in IS 196 : 1966.

8.2 Place the test specimen on the supporting plate so that the test specimen is fully supported and its surfaces are perpendicular to the direction of the applied load.

Apply the initial load (*see 5.3*) so that the point of contact of the indenter is not less than 10 mm from the edge of the test specimen. Set the depth-indicating device to zero and then additionally apply the test load F_m (*see 5.4*). Carry out the loading without impact, over a period of 2 to 3 s.

8.3 Choose the test load F_m from the specified values to obtain a depth of impression between 0.15 mm and 0.35 mm.

If the values of the depth of impression after 30 s are outside this range (either in the case of a series of test specimens or in the case of an individual test specimen), change the test load to obtain the correct depth of impression. The number of test measurements which do not give the correct depths of impression shall be reported.

8.4 Carry out the test in such a manner that any bubbles or cracks in the test specimen do not influence the results. If several determinations are carried out on the same test specimen, ensure that the points of application of the indenter are not less than 10 mm apart from each other and from the edge of the test specimen.

8.5 After 30 s of application of the test load F_m , measure the depth of impression under load, h , with the accuracy specified in 5.5.

8.6 Make ten valid tests on one or more test specimens.

8.7 Determine the deformation of the frame of the apparatus, h_s , in millimetres, as follows:

Place a soft copper block (at least 6 mm thick) on the supporting plate and apply the initial load F_0 . Set the depth-indicating device to zero and apply the test load F_m . Maintain the test load until the depth indicator is stationary. Note the reading, remove the test load and reset the depth indicator to zero.

Repeat this sequence of operations until the reading of the depth indicator is constant after each application of the test load. This represents the point at which no further penetration of the copper block takes place and therefore the constant depth reading is the movement of the depth-indicating device due to the deformation of the frame of the apparatus. Note this constant reading as h_s .

9 EXPRESSION OF RESULTS

9.1 Calculate the reduced test load, F_r , in newtons, as follows:

$$F_r = F_m \times \frac{0.21}{(h - h_r) + 0.21}$$

where

F_m = the test load, in newtons, on the indenter;

h_r = the reduced depth of impression (= 0.25 mm);

h_1 = the depth of impression, in mm, under the test load on the indenter;

h_2 = the deformation, in mm, of the test apparatus under the test load; and

$h = (h_1 - h_2)$ the depth of impression, in millimetres, after correcting for the deformation of the frame (*see Annex A*).

9.2 Calculate the ball indentation hardness from the equation.

$$H = \frac{1}{5\pi} \times \frac{F_r}{h_r}$$

where

H = the ball indentation hardness, in newtons mm^2 ;

F_r = the reduced test load, in newtons (*see 9.1*); and

h_r = the reduced depth of impression in mm.

9.3 For values of H lower than 250 N/mm^2 , round off to the nearest 1 N/mm^2 .

For values of H greater than 250 N/mm^2 , round off to the nearest multiple of 10 N/mm^2 .

10 TEST REPORT

The test report shall include the following particulars:

- Reference to this method;
- Complete identification of the material tested;
- Conditioning and conditions under which the tests are carried out;
- Description, dimensions and manner of preparation of the test specimens;
- Number of tests, averaged;
- Number of tests which resulted in incorrect depths of impression; and
- Ball indentation hardness, average value and standard deviation.

ANNEX A

(Clause 9.1)

VALUES OF THE BALL INDENTATION HARDNESS AS A FUNCTION OF THE DEPTH OF PENETRATION AND THE TEST LOAD

Evaluate the ball indentation hardness H using the formula

$$H = \frac{1}{5\pi} \times \frac{F_m}{h_r} \times \frac{0.21}{(h - h_r) + 0.21}$$

Depth of Impression, h mm	Ball Indentation Hardness, H (N/mm ²) for			
	$F_m = 49, 0 \text{ N}$	$F_m = 132 \text{ N}$	$F_m = 358 \text{ N}$	$F_m = 961 \text{ N}$
(1)	(2)	(3)	(4)	(5)
0.150	23.84	64.35	174.0	467.2
1.155	22.80	61.56	166.4	446.9
0.160	21.85	58.99	159.5	428.3
0.165	20.98	56.63	153.1	411.1
0.170	20.17	54.45	147.2	395.3
0.175	19.42	52.44	141.8	380.7
0.180	18.73	50.56	136.7	367.1
0.185	18.08	48.82	132.0	354.4
0.190	17.48	47.19	127.6	342.6
0.195	16.92	45.67	123.5	331.6
0.200	16.39	44.24	119.6	321.2
0.205	15.89	42.90	116.0	311.5
0.210	15.42	41.64	112.6	302.3
0.215	14.98	40.45	109.4	293.7
0.220	14.57	39.33	106.3	285.5
0.225	14.17	38.26	103.5	277.8
0.230	13.80	37.26	100.7	270.5
0.235	13.45	36.30	98.2	263.6
0.240	13.11	35.39	95.7	257.0
0.245	12.79	34.53	93.4	250.7
0.250	12.49	33.71	91.2	244.7
0.255	12.20	32.93	89.0	239.0
0.260	11.92	32.18	87.0	233.6
0.265	11.65	31.46	85.1	228.4
0.270	11.40	30.78	83.2	223.4
0.275	11.16	30.12	81.5	218.7
0.280	10.93	29.50	79.8	214.1
0.285	10.70	28.89	78.1	209.8
0.290	10.49	28.32	76.6	205.6
0.295	10.28	27.76	75.1	201.6
0.300	10.08	27.23	73.6	197.7
0.305	9.89	26.71	72.2	193.3
0.310	9.71	26.22	70.9	190.4
0.315	9.53	25.74	69.6	186.9
0.320	9.36	25.28	68.4	183.6
0.325	9.20	24.84	67.2	180.3
0.330	9.04	24.41	66.0	177.2
0.335	8.89	24.00	64.9	174.2
0.340	8.74	23.60	63.8	171.3
0.345	8.60	23.31	62.8	168.5

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Doc : No PCD 23 (1039)

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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